

AMERICAN UNIVERSITY OF BEIRUT

CAN SUSTAINABLE PASTURE MANAGEMENT IMPROVE
THE ECOYSTEM SERVICES FOR SMALL RUMINANT
FARMERS AND RURAL COMMUNITIES?
A CASE STUDY FROM WEST BEKAA, LEBANON

by
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ABSTRACT OF THE THESIS OF

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Title: Can Sustainable Pasture Management Improve the Ecosystem Services for Small Ruminant Farmers and Rural Communities? A Case Study from West Bekaa, Lebanon

Rangelands represent the most extensive land cover type of the earth's land area. They are natural ecosystems embracing genetic resources of microorganisms, animals and plants. Worldwide, rangelands' diverse ecosystems provide a wide diversity of services: some can be traded within traditional market systems others have intangible values. Given the unavailability and outdated policies in Lebanon toward the importance of these services to sustain these ecosystems, rangeland management plans must be set to preserve their services.

This study assesses the ecosystem services of rangelands in the chosen villages of the West Bekaa, to propose management plans for the use of these services in a sustainable way allied with regulations for a sustainable management of the rangeland.

This study was conducted in the West Bekaa, more specifically in the villages of Ammiq, Khorbet Qanafar, Ain Zebde, Saghbine, Bab Mareh, Aitanit and Machghara.

Data was collected from the database of the Environment and Sustainable Development Unit (ESDU) at the American University of Beirut (AUB). Information was retrieved on livestock farming, history and current status in addition to uses, grazing routes and adaptation strategies. Furthermore, data was retrieved from database on perceived rangeland ecosystem services by people who forage edible plants as well as changes occurring throughout time, any regulations enforced by the municipalities towards grazing and rangeland managements.

A case-study on pasture management plan was implemented in the West Bekaa to investigate the benefits it offers to the farmers and other stakeholders that were involved.

Results show that shepherds are shifting to sedentary farming systems following the depletion of pastures and their farming cost is increasing making it hard to continue with their activities in the absence of governmental support. Concerning people who forage, their benefits from rangelands differ between the selling of products, household consumption, foraging, hunting and woodcutting. Local authorities knowledge that grazing is forbidden in the villages but is practiced illegally, therefore there is a need for sustainable rangeland management plans accompanied with policies to enforce these plans, some of which are recommended, with an assumption of improving ecosystem services for pasture users.

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CHAPTER I

INTRODUCTION

Rangelands are natural ecosystems embracing genetic resources of microorganisms, animals and plants. They cover about one third of the earth's land surface. Rangelands are characterized by their diverse ecosystem services benefitting the human population.

They provide habitats for wildlife which their presence help perform key ecological services such as nutrient cycling and soil formation. Livestock provide food and fiber for its community by grazing the forage plants. In addition, rangelands dispense watersheds for the use of its surrounding and appropriately managed rangelands will protect the watersheds from erosion and pollutant runoffs. Recreation is an additional use of rangelands, also characterized by its aesthetic values.

Permanent rangelands are almost non existing in Lebanon and cover about 15% of the country's surface. Seasonal pastures are disproportionately distributed and located mainly in the Bekaa's northern plain and on mountain tops (Gintzburger et al., 2006)

To be able to generate these services and values, rangelands must be healthy and sustainable. If not sustained, these services can be easily degraded by human activities leading to their depletion. Regular woodcutting over diverse millennia, increased urbanized areas and cultivated lands, adding to overgrazing and lack of management and maintenance of the vegetation cover have led to the depletion of pastures in Lebanon.

For it not to be degraded, proper management should be implemented, coupled by policies. Sustainable management of natural pastures rely on the presence of regulations, responsiveness and implementation of their governed processes. Despite the several management plans formed and implemented in the MENA region and in Lebanon, the

long-term service linked to pastoralism and rangeland management appears to be missing or inefficient.

The chosen area to be studied is the West Bekaa as it is one of the most intensive agricultural regions: land and animal farming are both practiced in the area due to its fertile soil and high availability of water. Moreover, the West Bekaa anchors immense number of small ruminants and this sector is largely understudied compared to other regions

Despite the unavailability of laws and policies in Lebanon, law makers are generally unenlightened of the problem that pastoral communities face in order to intervene for their support. Can the development of sustainable rangeland management contribute to the enhancement of ecosystem services for small ruminant farmers and rural communities? In view of the natural and economic importance of rangelands, proper management plans must be set to protect, enhance, sustain and benefit from its services and resources for present and future generations.

This study aims to address this potential gap. Its purpose is to assess the ecosystem services of rangelands in the chosen area, and to propose management plans for the use of these services in a sustainable way allied with policies for a sustainable management of the rangeland.

CHAPTER II

LITERATURE REVIEW

A. Rangelands

Rangelands represent the most extensive land cover type estimated to 30–50% of the earth's land area (Kassam, 2002). Grasslands, forests, savannas, tundra, prairies, shrub lands, and deserts can all be referred to as rangelands; all lands that are not: cultivated, totally forested, covered by ice or built over (Sayre, 2017).

Worldwide, rangelands' diverse ecosystems are major, concerning the diversity of services they provide: forage for livestock and native animals, habitats for wildlife, wood products, watersheds for rural and urban uses and water for sustainable landscapes etc. (usda.gov). Aesthetic and societal values are also served by rangelands, such as natural beauty and wilderness. Moreover, these ecosystems can be easily degraded either by human made activities or naturally, such as overgrazing, drought, erosion, fires and other induced stresses, leading to the decrease of their diversity and, consequently, the amount of values and commodities they provide (NRC, 1994). Therefore, to be able to generate these services and values, rangelands must be healthy and sustainable. The self-sustained and properly functional ecological processes such as nutrient cycling, soil development, energy flow, and the structure and dynamics of their fauna and flora communities can achieve this regeneration (NRC, 1994).

In order for the human population to keep benefiting from rangelands as well as keeping them “safe”, appropriate management should be applied. Sustainable rangeland

management is a professional natural science that helps conserving and sustaining rangelands for the benefit of current societies and future generations (SRM, n.d.).

B. Rangelands in Lebanon

Lebanon includes two mountain chains parallel to the Mediterranean Sea, the western and eastern, separated by the fertile Bekaa Valley. It is characterized by its rich biodiversity due to its Mediterranean climate, as well as its vast geomorphologic regions. The mountains ranges, fertile plains and coastal zones, emerging new habitats, have attracted a vast range of species, leading to the development of distinct microclimates (MoE, 2016).

Historically, the country was once covered by forests. Its cedar groves were exploited and used as railroad fuel leading to eroded mountains with very little potential for afforestation. Regular woodcutting over millennia, shadowed by the growth of agro-pastoral activities has left Lebanon with antique forest patches and scrub vegetation (Fish, 1944). According to the Forest Resource Assessment done in 2005–2006, the Lebanese forest cover was estimated to be 13% and 10% of woodlands (Dalsgaard, 2005). Hence, there are many factors that have affected the land cover in Lebanon. First, rangelands in Lebanon are decreasing because of the invasion of agriculture and the urban sprawl. The Lebanese population was 2,297,434 in 1970, it increased to 6,825,445 in 2020 (World meter, n.d). Consequently, urbanized areas went from 221 km² in 1963 (Faour, 2014), to 836 km² in 2019 and expected to reach 884 km² in 2030 (CDR, 2004). On another hand, the ministry of agriculture reported (MOA, 2012), that in the 2000, the agricultural surfaces occupied approximately 25 percent of the country surface, however the recent

figures of the World data atlas, in 2018, indicate that 658 thousand hectares, approximately 63%, of the Lebanese territory is covered by croplands

Another factor affecting rangelands in Lebanon is the impact left from wars and armed conflicts on the Lebanese land which was altered directly due to the arrangements as mentioned by Biswas (2000), and indirectly as the result of changes in the way of life of inhabitants and their use of natural resources as argued by Mubareka and Ehrlich (2010). Therefore, lack of management and maintenance of the vegetation cover caused by inaccessibility to lands due to repetitive armed conflicts have led to fuel accumulation, which increased hazards of intensive and severe fires affecting the natural recovery of vegetation, and degraded soil quality (Mitri and El Hajj, 2013). Talhouk et al. (2001) reported additional causes of land degradation: “The mountain ecosystems of Lebanon are characterized by steep slopes, intense winter rainfall and long dry summers. Recent uncontrolled expansion of coastal cities and summer mountain resorts, and agricultural expansion in rural areas, have exacerbated land degradation caused by landslides, flash floods and forest fires. It is estimated that 800,000 sheep and goats are using woodlands and degraded highlands for at least 2 months per year”. The uncontrolled grazing plays a role in biodiversity depletion and ecosystem fragmentation.

Rangelands in Lebanon, cover 47.5% of the total area of the country of which 62.3% is classified as grasslands (Darwish et al, 2012). The enlargement of cultivated lands and depletion of rangeland, correlated with the low productivity of rangelands, have led to overstocking and overgrazing of vulnerable lands and have accelerated the process of land degradation (Moumen, 2011). The Bekaa valley is known as the center of small ruminant production in Lebanon and dominates about one third of its territory. This sector depends mostly on rangelands during summer and spring, in addition to crop leftovers as

source of feed. The northern part of this valley mainly includes the rural communities of Hermel and Aarsal owning the major herds. Aarsal shepherds depend on pastures as they are landless, to secure about half of their flock's feed. The farmers of Hermel count on transhumance, reaching 200 to 300 Km in their grazing routes (Srouf, 2006)

The West Bekaa region anchors large numbers of small ruminant, 34% of sheep in Lebanon mainly "Awassi", 25% of goats in Lebanon, mainly "Shami" and "Jabali", in addition to cattle farms spread across the valley (mainly include the dairy "Holstein" breed) (Asmar, 2011). Shepherds in Northern Lebanon move to Syria with their flocks seasonally. During summer, Lebanese rangelands receive semi-nomadic flocks coming from the Syrian Desert to the Bekaa as well as local migration from low altitude to high peaks in the Western Mountain chain (Sattout, 2014).

C. Rangeland services

Although they seem unproductive at first sight, rangelands hold a large number of valuable uses for the environment and the local communities. According to Sala and Paruelo (1997), several benefits given by nature that people value are called ecosystem services in the conservation world. Rangelands take the place of the natural ecosystem from where a large fraction of domesticated species originated and where annual grasses and legumes are most plentiful. When talking about rangeland ecosystem services, some can be traded with traditional market systems like hay, meat, and other livestock products, others have intangible values like cleaner water, enhanced air quality, and decrease of risk from drought or flood. These services are divided into four categories (Sala and Paruelo 1997).

Livestock provide food and fiber for its community by grazing the forage plants and turf that grow in these lands. This is one of the economic services of rangelands. Another importance of the rangelands is the provision of habitats for wildlife. The settlement of these habitats enhances the biodiversity of the land and brings strength to the ecosystem (Thorne and Harper, n.d.), which will help perform key ecological services such as nutrient cycling and soil formation. It is important to mention that grazing by domestic livestock can affect wildlife habitat in several ways. The organization of a plant population is directly associated with the quality of wildlife habitat: “as much as livestock grazing can affect vegetation characteristics, it will affect wildlife habitat structure and productivity” (Krausman et al., 2009). In addition, rangelands dispense watersheds for the use of its surrounding circle by providing drinking water, purifying the water due to the available vegetation that plays a role of purifier and appropriately managed rangelands will protect the watersheds from erosion and pollutant runoffs (Gillaspy, 2013). Recreation is an additional use of rangelands where the beauty of the landscape and the open spaces are favorable for outdoor activities (hiking, fishing, hunting, biking...). It is also characterized by its aesthetic values and of attractive, large and visible species (Krausman et al., 2009) and the large spaces of lands favor the location for renewable energy sources, such as wind and solar power (Gillaspy, 2013).

Ecosystem services include acquired products from ecosystems that can be directly consumed and generally have a market value, some of which are fiber, fuel, freshwater for drinking and irrigation, medicinal products and forage to produce meat, milk, wool, and leather (Sala and Paruelo 1997). For example, small ruminants have a major part to play in the economy of Lebanon through their contribution in the income to the community associated with pastoral activities, varying their production systems in the

mobility of the herds, their use of rangelands, their size and composition. This pastoralism was seen in the West Bekaa as it is one of the most fertile regions of Lebanon, hosting large numbers of small ruminants (Hamadeh et al., 1996) but has shifted to a sedentary and crop-based system in recent studies (Hamadeh, 2021).

In contrast, cultural services are nonmaterial benefits that the community obtains from ecosystems, to mention cultural diversity, spiritual, and religious values, knowledge systems, and recreation, related to human experiences associated with tourism, wild game hunting, and traditional lifestyles.

The third category is the regulating services: climate regulation, air quality maintenance, water purification, and erosion control, that people receive from regulating ecosystem processes (Sala and Paruelo 1997). For example, if rangelands were degraded or transformed into agricultural lands, the large quantities of carbon sequestered into the soil of these rangelands will be released into the atmosphere and will cause pollution. Wetlands are known throughout the literature for their ability to clean water, reduce flooding and promote biodiversity. Aammiq wetland is Lebanon's richest biodiversity site, constituted of rocky hills, fertile fields and rich oak forest of the West Bekaa. It is a recreational and touristic site that people come to visit. It was designated an Important Bird Area in the Middle East particularly during migration season to glimpse large herds of White Storks, Pelicans, Eagles, Buzzards and water birds (Serhan and Khatib, 2014).

Concluding with the most important category: the supporting services. These are necessary for the maintenance and production of all other rangeland ecosystem services, namely nutrient cycling, soil and biodiversity conservation which constitute a vast storehouse of genetic, species, and functional diversity (Sala and Paruelo 1997).



Figure 1 Rangeland ecosystem services

D. Legislations, laws and policies

1. On the national level: Lebanon

National laws on land use and land occupation in Lebanon concerning rangeland management and its preservation are either outdated or non-existing. The Lebanese forestry law dating back to 1949 comprises 18 articles related to grazing in relation to forest management. Some of which:

Article 23: It is not allowed for anyone who won the right for pasture through bidding or consenting to enter into the forest a number of animals that exceeds the number specified in the condition book, and all the animals should have a specific mark for tracking and it is not permissible to leave the animals outside the roads and the places allocated to them.

Article 92: The Minister of Agriculture should impose mandatory protection of pasture areas from grazing livestock when the Minister sees necessary reasons for the protection

or maintenance for reforested areas, whether the property is of the state or the municipalities and villages, or for individuals. And the Minister of Agriculture should decide to move out the goats from village lands if the owners of three-quarters of the area ask for measures to be taken. The measures are that each family that owns goats can keep three heads only tied with a rope outside the land and it is forbidden to enter public lands or communal or private property.

One of the restrictions of rangeland management in the region is the land tenure system. Grazing territories and pastures limitations are not clearly determined or assigned to village tribes or communities. In the absence of clear and proper land tenure system, and despite creditable attempts in many countries, users have no incentives to invest or properly manage pastures (Naghizadeh et al, 2021). When talking about rangeland uses, especially for grazing, different land tenure systems are set in Lebanon. These systems prevent conflicts between landowners, municipalities and the shepherds. Clerical societies have been given applicable rights and uses over lands to secure seasonal movement of shepherds with their herds within a set of terms and conditions on all types of lands except protected forests, and nature reserves as well as lands falling under compulsory protection (burned areas and young forests/woodlands). The MOA sets these terms and conditions defining the period of permitted grazing practices, including size of packs, tagging the animals and respecting the rangelands' boundaries (Sattout, 2014).

Municipalities and neighboring villages are usually given rights over governmental lands, especially for grazing, practices are defined based on a series of criteria and it is banned in degraded sites protected for reforestation purposes. These decisions must be coordinated with the MOA, as well as landowners that want to lease their fields for

grazing after submitting a request to the local forestry department unit. Consequently, the parcel is declared protected by ministerial decision (Sattout, 2014).

Another point to add is that the restriction of transhumance on private lands is conditional on the approval of a request to ban the passage of livestock by 75 percent of private landowners. Therefore, packs movements are detracted and herders are given an alternative: to own only six goats each with grazing rights only in their own farm (Sattout, 2014).

2. On the municipal level: West Bekaa

Despite the unavailability of laws and policies, law makers are generally unenlightened of the problem that pastoral communities face in order to sustain their livelihoods. Can the development of sustainable rangeland management contribute to the enhancement of ecosystem services for small ruminant farmers and rural communities? Therefore, viewing the natural and economic importance of rangelands, proper management plans must be set to protect, enhance, sustain and benefit from its services and resources for present and future generations.

E. Rangeland management

1. Rangeland management plans in the MENA regions and Lebanon

Out of billions of hectares of pastures globally, 303 million hectares are situated in the MENA region. The region is dominated by the Mediterranean bio-climate: long, dry and semi-hot summer, and rainy, snowy and cold winter, and an arid and semi-arid climate, with unpredictable and low rainfall. This region is the mother of livestock's

domestication performed through mobile pastoralism, shepherds searching for water and feed and escaping from harsh climate (Naghizadeh et al, 2021).

In a paper entitled "Financial incentives: Possible options for sustainable rangeland management?" (Louhaichi et al, 2016), sustainable rangeland management practices (SRMPs) have been proven to be keys for feed shortage and rangeland deprivation, some of which recommended to the Bedouins in Syria are:

- Periodic resting used to ameliorate degraded lowland pastures by protecting it for two years from continuous grazing and allow natural vegetation to self-recover. This is the cheapest alternative to recover pastures.
- Direct seeding or broadcasting that only needs a tractor for shallow scarification of the soil, previous broadcasting. Direct seeding reduces the cost of transplanting shrub species.
- Shrub transplantation of grown seedling in a nursery. Although this method is the most expensive rehabilitation measure, it is the most practiced in the MENA region following its highest biomass productivity in a short duration.

These three methods have respectively 50%, 20% and 10% potential adoption rates for increasing farm income. Throughout this study, it has been shown that Bedouins haven't changed their unsustainable practices despite their familiarity with the beneficiary principles of SRMPs, thus, this case study confirmed by a hypothetical expectation that higher financial incentives will lead to an increased adoption of the technologies of SRMPs, and needs to be followed by institutional arrangement to enhance decent governance. After introducing this incentive, adoption rates of these methods increase to 100%.

Following the increase of human population in the Mediterranean region (arid and semi-arid), demand for meat has increased, thus demand of forage for animal grazing has escalated. Therefore, increased barley cultivation has led to severe degradation of pastures. In 2003, field experiments were conducted in Jordan to evolve a method for establishing *Atriplex* seedlings to increase its productivity. It has been shown that cutting the shrubs at 45 cm increases the amount of regrowth sustainability, in addition, water-harvested contour furrow at 100-200 mm is reasonable for an enlarged biomass production (Abu-Zanat et al, 2004).

In Menaal Ebrahim's report under the guidance of the World Bank, submitted in fall 2019 (Ebrahim, 2019), recommendations prioritizing the MENA region rangelands restoration. Pasture management can be enhanced by selecting adapted species resistant to drought. In addition, degraded pastures can be restored by planting species that are palatable and nutritious to livestock: *Atriplex*, acacia, spineless cactus were successfully introduced in Tunisia and Algeria. Moreover, herds can be separated to overcome overgrazing. In this report, it has been mentioned that within the updated national rangeland strategy in 2013, a holistic approach was used for land restoration, building on the Hima's ancient tradition, integrating community life, natural resources, animal welfare, ethics, etc... Its main aims were sustainable development management for pastures, enhancement of economic and social situations for livestock breeders and pastoralists, highlighting gender problems, training and awareness, managing and evaluating pasture statuses and engaging local communities in sustainable pasture management. Following this updated strategy, improvement of pastures in Jordan has been observed: grasses and shrubs are regenerating and indigenous species are

reappearing. Moreover, the involvement of women has improved their livelihoods by safeguarding their tenure and organizing rights and have entered government institutions.

Lebanese rangelands are severely degraded and stress from reduced productivity caused by the negative impact of past mismanagements, erosion and overgrazing. Therefore, the country's rangelands better be sustained and regenerated where it has been deteriorated. To fulfil this, rangeland conservation and correct management would be serviceable becoming a part of the agricultural and environmental commitment; it can also receive resource allocations in proportion to its value to the population and to the country itself. To develop a rangeland management plan, it would be beneficial to be a combined multi-dimensional exercise: not only should it manage the vegetation cover and local technical specificities, but socio- economical, administrative and legal criteria can mold the scope and content of the plan. Several researches were conducted in Lebanon concerning rangelands managements in addition to development projects mainly in the private sector.

In a project titled Assessment and evaluation of grazing activities at the Shouf Cedar Nature Reserve (Abi-Said, 2011) conducted by Dr. Mounir Abi – Said, more specifically in his report “assessment and evaluation of grazing activities at the (SCBR) Phase II”, a management plan was proposed to solve the conflict between the shepherds of the Bekaa and Shouf villages demanding a larger space for grazing and the Shouf Reserve who wants to establish the Shouf Cedar Biosphere Reserve. In addition, helping shepherds in land distribution can resolve the conflict among them, release the tension between them and give them more access to rangelands. Moreover, the developed grazing management plan relied on grazing rotations, duration, monitoring of vegetation cover and water availability, following the water scarcity problem faced by the shepherds that limits their

grazing movement and emphasizes their demand for a clean water source available yearlong. In response of the shepherds from both sites claiming that the grazing area is not sufficient for them, it has been seen that the plan accounts for changes in stocking rate according to the land's carrying capacity for a certain year.

In 2008, Darwich and Faour have chosen two mountainous pilot areas with contrasting climatic conditions, Kfarselouane and Aarsal, in order to analyze the vegetation dynamics, the impact of environmental and social factors on Lebanese mountains' rangelands degradation. Acquired results showed an imbalance between carrying capacity and the grazing pressure, as well as a change in land use leading to forest expansion in Kfarselouane and fruit trees in Aarsal on the cost of rangelands. Therefore, the writers advocated a unified pasture-fruit tree production with irrigation as a feeding supplement for the animals in the dry months.

In 2014, the SPNL included in their report within the Mediterranean consortium on "Assessing and supporting cultural conservation practices in the Mediterranean Phase 2" that the shepherds should be part of the decision and policy making regarding pasture management, in order to develop more adequate and efficient policies. In addition, the permanent pastures in Lebanon, which represents almost 15% of the country's land cover, are not regulated by any governmental policy following the lack of data, which averts the Ministry from developing sustainable management policies, along with social, economic and political conflicts (Hamadeh, 2019).

The main Stakeholders, MOA, MOE, FAO, and the forestry department, with the collaboration with local municipalities, are trying to conduct several trials or suggestions of new rangeland management plans. In 2020, the Food and Agriculture Organization of the United Nations (FAO) in Lebanon and the Ministry of Agriculture (MoA) teams care

trying to establish a rangeland management plan for the community of Tannourine. Several field visits aimed at evaluating sample plots of species make-up and productive capacity taken from the high mountain rangeland to capture the variability of the site. From the data collected, the carrying capacity of the site is being analyzed. After gathering the relevant social and economic data, a solid rangeland management plan will be held.

Moreover, the UNDP have published their report in 2018 under the “Sustainable Land Management in The Qaraoun Catchment” (SLMQ) implemented in Zahle, Rachaya and West Bekaa in order to reduce overgrazing and give local authorities a better control and management of the endangered rangelands and forests. For this achievement, technical support must be provided to the municipalities and shepherds in addition to awareness workshops to evaluate the status of the rangelands and potential zoning areas to be therefore managed. By the end of this implementation in 2021, it is expected that guidelines for rangelands management will be published, activities for rangelands rehabilitation will be initiated with the use of rangeland imprinter and management plans for rangelands outside forests (RMP) are going to be developed.

In 2021, Dr. Hamadeh finalized his second report “Rangeland management plans prepared for Baalback and Nabatieh” including the rangelands management plans for two demo-plots identified in both areas in the framework of the “Climate Smart Agriculture: Enhancing Adaptive Capacity of the Rural Communities in Lebanon” (AgriCAL) project, and was submitted to the MoA and IFAD. The management plan for both sites was based on interviews with local stakeholders and on-site field visits, and rapid grazing assessments to determine their carrying capacity and stocking rate to help develop a successful rangeland management plan. The method used to determine the carrying

capacity was clip and weigh: "the harvest of standing forage at a given time in order to predict available forage" (Sedivec and Printz, 2014). For the management plan, it is important to involve local stakeholders to ensure a sustainable and successful management plan. For this participation to be efficient and cooperative, incentives are advised to be offered to farmers, like training on flocks, marketing for their dairy products, distribution of free vaccines and drugs, in addition to medical consultations to encourage the farmers to participate in the implementation of the suggested plan. Moreover, a rangeland rehabilitation scheme has to be built to improve rangeland quantity and quality and decrease the tension between shepherds among them and between them and local authorities. The actions proposed within the rehabilitation plan are the following:

- Water management: in the Qaa mountain rangelands, artificial ponds and cisterns, limited to the grazing season, can be adopted for herds to drink when natural ponds filled with rain are no longer available in early spring. In Nabatiyeh, temporary water points can be established on site, such as water reservoirs and small ponds filled via cisterns from nearby water sources, to prevent competition over water with the start of irrigation season.
- Re-seeding of native legumes: in al Qaa rangelands, there is not a significant presence of legumes, therefore, the plantation of winter legumes tolerant to frost can contribute to the rehabilitation of degraded pastures, as well as used as forage for herds before moving to grazing with the beginning of temperature rise in spring. This can also be applied in Nabatiyeh, as this implementation be done during the rainy season to prevent the used of irrigation.

- Rotational grazing: for both Al-Qaa and Nabatiyeh ranges, rotational grazing is suggested: each plot is divided into eight plots of equal grazing capacity and each is grazed for five days, and the herd is moved quickly from one plot to the second. The movement of the herd allows the regeneration of the pasture gradually. Slopes, water availability, carrying capacity and the season should be taken into consideration. This activity allows decrease of plant selectivity resulting to a higher number of grazed plants, in addition to the improvement of water infiltration into the soil. Moreover, will improve animal performance and rangeland conditions, increasing the period of available green forage for livestock.

In 2022, ESDU in collaboration with local agricultural organizations in Baalbek, Aidamoun and Hasbaya, finalized their pilot project titled "Climate 2: Climate and livestock: Mainstreaming appropriate technologies", funded by the WFP, aiming to strengthen the resilience of farmers in the small ruminant sector and the rural communities, in face of climate change, through sustainable solutions based on circular economy principles. This project achieved three outcomes:

- Outcome 1: Improved skills and capacities for small livestock farmers and feed providers.

Training of small livestock farmers and feed providers was conducted. Advanced training followed the main training. Topics perceived included business, marketing and soft skills, sustainable agriculture practices, livestock management practices, composting...

- Outcome 2: Grazing guidelines and sustainable management plan for rangelands.

The rangeland management plan included: **involving local stakeholders** to ensure a successful and sustainable management of the development plan. **Incentives for farmers**

to ensure an active cooperation and participation of the farmers, included training on flocks and milk production to ameliorate their income in addition to marketing improved dairy products by ecotourism activities. Distribution of vaccines and drugs and medical consultation. Moreover, improve linkage with local NGOs therefore municipalities be encouraged to participate and support proposed plans. For **water management**, cisterns and artificial ponds can be installed. In Aidamoun, small structures can be put in place to harvest rain water, following the interest of local shepherds. In Hawch El Nabi, solar powered pumps can be installed to increase the cost of pumping water as artesian wells are used for irrigation and for herds. **Re-seeding native legumes** to improve the rangeland fodder production as some species are highly tolerant to stressful environment and highly nutritious for small ruminant. Concluding with **rotational grazing** to improve animal performance and pasture conditions, increase the availability of green forage, reduce plant selectivity and improve water infiltration.

- Outcome 3: Successful adoption of innovation and technology through pilot interventions in form of living labs.

This gave the opportunity to farmers to interact directly with technologies addressing sustainability features. Some of the technologies used in the living labs: Barley - Sprouting units – Rain harvest system - Composting units - Water pumps - Water tanks - Solar technology.

2. Case study of West Bekaa

In the West Bekaa, and similarly to other regions in Lebanon, grassland use is controlled by the municipalities according to the MoA forestry laws. However, following the absence of formal regulations set by the municipalities, the treaties are commonly

made orally between the municipality and the shepherds. Below are some of the region's management plans:

In 2019, Chedid presented the challenges facing agro pastoral systems in Lebanon, specifically in the Bekaa valley, and the technical solutions for these challenges. The challenges faced were the lack of policies and laws related to pastoralism and land tenure, urbanization and rural migration blocking the flexibility of animal movements leading to the concentration of animal stocks on the same lands causing overuse of these lands. In addition to converting the marginal lands to crops preventing their use as rangelands, deforestation, overgrazing, as well as the climate viability, the lack of technical skills and data for range management prevents the pastoral system from improving. To solve these challenges, Chedid et al. (2020) have suggested a reduction of the pressure on pastures by controlling the herd's size complemented with a managed carrying capacity, therefore, increasing flock productivity and allowing the grass to regrow. Degraded pastures should be improved by reseeded it with native legumes and grass with a mixture of fruit trees, which allows nitrogen fixation in the soil and water preservation, thus, rehabilitating the pasture. Moreover, shrubs species that are resistant to drought, adapted to the local soil type and rich in biomass can be planted in order to compensate the deficit in pastures. Pastoralists' cooperatives must be established in order to facilitate technology and knowledge transfer between the shepherds to improve small ruminant production and providing market access.

It is important to mention that taking farmers' perception into consideration while planning development programs and policies, results in formulating appropriate interventions easily accepted by the farmers and helps researchers understanding the parameters they are willing to analyze. This can be explained by a study conducted by

Chedid et al. (2018) investigating the main constraints affecting small ruminant production in the West Bekaa of Lebanon as perceived by the farmers, and their reported adaptive strategies. The difficulties faced by the shepherds are the climate variability that affects rangelands' productivity, the insufficient available water pushing farmers towards more cost for tractors pulling water tanks. In addition, milk and feed price fluctuation, competitive prices of illegal animal products as well as unaffordable access to treatment and veterinary services are common challenges for smallholders. However, farmers have come up with various adaptation strategies such as increasing feed supplementation and changing in the feeding strategy, reducing and modifying the mobility of the flocks, and the reduction of the herd size. These adaptation strategies in addition to more inductive governmental policies covering land tenure and pasture management, market and border regulations and improved financial and animal health services, can achieve the sustainability of the small ruminant sector in West Bekaa.

F. Rangeland challenges and recommendations

1. On the national level: Lebanon

In the recent study conducted by Hamadeh et al. (2019) the investigators found that updating rangeland policies should be based on successful experiences and involve all stakeholders including shepherds, landowners, municipalities, and experts. In addition, to avoid increased impact of the projects and avoid replicability, cooperation and exchanged information and experience should be exercised between the different parties of the projects on pasture management and grazing. This participatory approach promoting community-based range management was also suggested by the SPNL, and have given a technical solution for degraded pastures improvement by reseeding grasslands with native

species, therefore ameliorating pastures quantitatively and qualitatively, reducing feed supplementation needs.

Two recommendations were given by Darwich and Faour (2008): “A controlled grazing within silvi-pastoral and silvi-horticultural systems can sustain the interest of new generation to implement and sustain land conservation measures” in addition to “improving the income of local population from agriculture, rainwater harvesting and the production of export fruits can enhance population involvement in rangeland management as a part of the ecosystem”.

An aggregated approach was also given by Sattout (2014) for pastoralism preservation, suggesting that rangelands management should be institutionalized while mobilizing human resources, building capacities of stakeholders, studying rangelands ecosystem as well as vegetation carriage and protecting cultural aspects of landscapes through empowering herders in the lands.

Moreover, in several case studies (Abi-Said, 2012, Chedid, 2019), it has been seen that there are complaints by the shepherds about water scarcity restricting their movement and limit their grazing distance. Concomitantly, Abi-Said (2012) suggested, provision of a permanent water source away from the reserve core area, helping the shepherds by reducing or eliminating water cost. This will also make the shepherds more collaborative with the SCBR for this service, and consequently, it will prevent them from going further into the reserve since shepherds can stay far away from the water source. It was also mentioned by Dr. Abi-Said that grazing rotation, stocking rate, duration and surveillance of vegetation cover should be included in the rangelands management plans.

An important challenge facing the rangeland management is the lack of technical skills or specific rangeland technologies promoting weak research developed over the past three to four decades. Therefore, overgrazing and deforestation resulting from mismanagement are either due to the ignorance or to the inflated financial and human investment. Hence, the low short-term financial return of pastoralism may justify the expansion of urban areas and intrusion of agriculture on rangelands in addition to the low interest of youth in farming (Chedid, 2019).

2. On the municipal level: West Bekaa

In the West Bekaa, the small ruminant sector is largely understudied, particularly in the rangelands management sector, therefore, a wide range of practices and recommendations are given in the literature in order to restore degraded rangelands or preserve its health.

Following the study by Chedid et al. (2018) focusing on identifying the adaptation strategies of small ruminant production systems in the West Bekaa of Lebanon based on the farmers' perception of change and its driving forces, some challenges were faced toward the development of the small ruminant value chain. To begin with the inadequate policies regulating land use and pasture management, succeeding the limited governmental role for the purpose of control and market regulations, adding the lack of veterinary and financial services. Therefore, it was suggested that the sustainability of the small ruminant sector in West Bekaa could be enhanced by more inductive governmental policies covering land tenure and pasture management, trading regulations and upgraded financial and animal health services.

Within the project implemented by SPNL in collaboration with the Union of Municipalities of Bouhayra, provision of technical support to municipalities and herders will increase the realization of the importance of natural resources, and improve management of rangelands and grazing areas. For this to be achieved, municipalities will implement zoning action plans and will train their staff on monitoring the defined zones to ensure sustainability and proper management, in addition to different awareness workshops for herders. Another issue tackled is that natural forests and green areas in the region were negatively influenced by urbanization and overgrazing. Reforestation is the main long lasting recommended solution, despite the right tree types of the area, trees that can provide extra income for the local communities can also be planted (UNDP, 2018).

CHAPTER III

METHODOLOGY

A. Justification of the chosen area

The West Bekaa is crossed by the Litany River forming in its center an artificial reservoir used mainly for irrigation and hydropower, called the Qaraoun Lake (El Hage et al., 2019). The region is characterized by a semi-arid climate affecting the production and seasonality of important crops such as potato, wheat and apples. The West Bekaa's main landscape is dominated by agricultural fields and natural vegetation, and has a rich and large biodiversity with multiple ecosystems, providing habitats for plants and animals (MoE/GEF/UNEP/Elard, 2015).

The West Bekaa is one of the most intensive agricultural regions: land and animal farming are both practiced in the area, this is because of its fertile soil and high availability of water. Its main agricultural activities include:

- Crop production of fruit trees which constitute one of the most important sub-sectors in term of socio-economic impact, production and rural development. This production includes apples, cherries, peaches, pears, almonds, apricots, plums (Choueiri, 2001), and most importantly grapes, which has a high value in domestic and export markets (Antoun, 2014). Legumes and vegetables are another important crop production in the West Bekaa area such as eggplants, zucchini, cucumbers, watermelon, beans, lettuce, carrots and tomatoes (Chalak and Sabra, 2007). Moreover, wheat, freekeh and barley are the main field crops. It is important to mention that crop residues are a treasured source of animal feed and contribute as an important part to small ruminants' diets. It was found that

ruminants have the capacity to convert low quality fiber into high value products like milk, meat, manure, and leather. And in parallel to the nonstop decrease of natural pastures that are overgrazed, crop residues can be a major feed source available after crop harvest. Supplements like nitrogen can be added to enhance their nutritional values; vitamins and minerals can also be added for a higher palatability (Bhandari et al, 2019).

- Animal farming: The West Bekaa is one of the most fertile regions of Lebanon, rich with large and small-scale dairies, big small-ruminant herds and mixed farming systems. Its small ruminant sector is largely understudied, especially in comparison with the North Bekaa. Nevertheless, this region holds a huge proportion of the Lebanese small ruminant farmers that are also subjected to climate inconsistency: approximate to 80,116 (38.8% of the Bekaa goatherd) heads of local baladi goats and 40,364 (21.2% of the Bekaa sheep herd) of fat-tailed Awassi sheep (Chedid et al., 2018). Dairy production is one of the centers of the agro-industrial sector. Sheep milk production extends from April to July, while goat milk production is from May to November. Most of the dairy units are traditional and managed by cooperatives and local families, in addition to an important number of small-scale dairy units, dispersed across the region, and which is run by families to provide their livelihoods. It is important to mention that beekeeping is a familiar activity, playing a major role in rural development, valorization of natural resources and decrease of poverty.

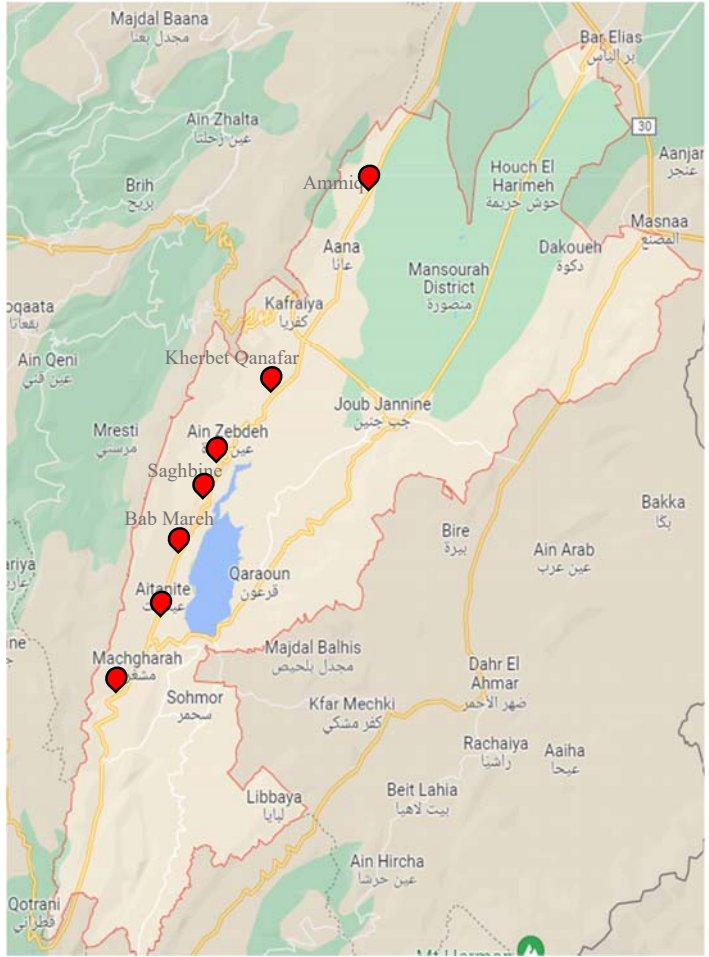


Figure 2 Visited villages in West Bekaa

B. Data collection

Data was collected from the database of the Environment and Sustainable Development Unit (ESDU) at the American University of Beirut (AUB), which has been focusing their work since 2014 on the West Bekaa and its agricultural value chains namely small ruminant production. Many projects of ESDU focused on rangeland management, including surveys on the available municipal decrees, common practices related to pasture management, the challenges faced by the shepherds and other pastures users, farmers' perception of change, perception of rangelands and their services, etc. Additional data was collected from ESDU key persons in the West Bekaa such as project coordinators and field officers. Reference was also made to previous and ongoing projects implemented by ESDU in the West Bekaa and other Lebanese regions.

It is also worth mentioning that I had the opportunity to work with ESDU and had the chance to participate in several projects with components related to rangelands such as:

- Climate 2: Climate and livestock: Mainstreaming appropriate technologies (2022) funded by the WFP
- Climate Smart Agriculture: Enhancing Adaptive Capacity of the Rural Communities in Lebanon” (AgriCAL) (2021)
- Assessment of rangeland management policies and practices in the West Bekaa, funded by the University Research Board (URB) (2020-2021)

The villages that were selected for this study are: Ammiq, Khorbet Qanafar, Mashghara, Bab Mareh, Saghbine, Aitanite and Ain Zebdeh, which are all located on the West side of the Litani river, over the same line parallel to the Western Lebanese Mountain chain. In addition, to sharing comparable landscape, the small ruminant systems in these villages are very similar:

- They use rangelands of the same nature and type
- They rely on the same grazing and feeding practices where herds graze in the mountains during Spring and Summer, and when pastures become limited during autumn, they move to the plains to feed on crop residues
- They are supplemented with hay and grains especially during winter

Data was retrieved on farm history and current status in addition to small ruminant production (number of heads, sources of feed and feeding mixtures...), as well as pasture uses and grazing routes (table 3), on-farm changes and adaptation strategies. Data on foraging activities was also retrieved including perceived rangeland ecosystem services as well as changes occurring throughout time.

Table 1 Summary of the main information retrieved

Activity	Data collected
Shepherds	<ul style="list-style-type: none"> - Farm history and current status - Small ruminant production (number of heads, feeding systems, etc.) - Labor at the farm - Pasture uses and grazing routes - On-farm changes and adaptation strategies
Foraging	<ul style="list-style-type: none"> - Perceived rangeland ecosystem services - Information about rangelands (location, tenure...) - Changes occurring throughout time - Presence of rangeland management plans

The 5 local authorities shared information on rangeland statuses, available management plans, conflicts between the municipality and the shepherds, and among shepherds, and suggested solutions and recommendations to avoid these conflicts and sustain these pastures.

Table 2: Summary of local authorities key person contacted

Local authorities key person	Village	Data collected
Mayor	Machghara	- Municipality regulations
Deputy mayor	Aitanit	- Rangeland status - Management plans
Mayor	Ain Zebde	- Conflicts and suggested solutions
Mayor	Kherbet Qanafar	- Recommendations
Municipality key person	Saghbine	

All contacts were available in ESDU database.

Secondary data was collected from peer-reviewed literature, trusted websites and scientific publications.

C. Constraints

Multiple obstacles were faced throughout the data collection, these can be summarized as follow:

- The Covid-19 pandemic which drastically changed the way of living and working
- Canceling field visits, and on-site observations, which put a pause to the data collection for a period of time

- Vehicular mobility from Batroun, my hometown, to the West Bekaa became less desirable and more expensive due to fuel shortage and economic crisis
- In Machghara, a huge conflict occurred between shepherds, making it hard to contact the farmers or even entering the village.
- In Ain Zebde, grazing has been forbidden for a period of time because of the damages caused by the herds, therefore, major shepherds sold their flocks and few shepherds were left with limited herd size.

D. Data analysis

Following retrieval, a descriptive analysis was used to capture the small ruminant sector practices in the West Bekaa on a small scale, as well as its rangeland services and the point of view of the local authorities of the chosen villages.

The small ruminant sector of the visited villages is described using descriptive statistics such as the average size of herd in the villages. The herds are categorized into milking goats and ewes on average and bucks, and fattened kids and lambs per season, in addition to the average of new born per year.

On another hand, it was important to describe the pasture use and grazing routes of the shepherds in each village in case of rangeland management plans further on.

In the winter days, when the shepherds cannot take their herds for grazing, on-farm feeding is the main source of feed and which has the highest cost on the farmers' daily routines, about 60% of the total production cost, or more, having the largest impact on reproduction, growth of lambs and kids and on milk production (Campbell, 2019).

Concerning people who forage, the major part is to site the different benefits they gain from these pastures to be enhanced, and their characteristics to further identify their ecosystem services.

A comparative analysis was conducted between the literature review and the data retrieved, and between the West Bekaa and other areas in Lebanon and the Mediterranean area, based on available data and resources. Aspects that were compared include rangeland management plans implemented or suggested, success stories and lessons learnt from Lebanon and case-studies from the MENA region and the Mediterranean.

A case-study on pasture management plans was implemented in the West Bekaa to investigate the benefits it offers to the farmers and other stakeholders that were involved.

E. Case study identification

The identified case study is in Saghbine Mountains in the West Bekaa, where a rangeland management plan was developed by ESDU under a project implemented in 2020 by the Society for the Protection of Nature of Lebanon (SPNL). The project is entitled "Building the ecologic and socio-economic resilience of the Shouf Mountain Landscape by restoring and strengthening the socio-cultural fabric which sustains its biodiversity and cultural values". To go deeper into its identification, having access, through ESDU database, to the study proposal, reports and keypersons involved, I had the chance to communicate with people that participated in the project (project coordinators and field officers), either from ESDU or SPNL team. Several challenges were confronted through the execution of the project and will be further explored in the results and discussion part of the thesis.

F. Description of the case study

For the design and implementation of the restoration plan, a 150dn pilot site of degraded high mountain rangeland was located by ESDU and SPNL.

Data in the project area was retrieved on farmers' perception to rangeland management elements as well as challenges they are facing and their needs. As the data categories included:

- Farm current status and history
- Feed management
- Pastures and grazing practices
- The relationship between the shepherds and local authorities
- The ruminants' value chain as production, marketing, processing, etc.

To prevent overgrazing the pastures, the carrying capacity of the rangeland was determined. To do so, a rapid grazing assessment was conducted in April 2020 during vegetation growth season, and pasture assessment was done using a subjective scoring system constructed on estimating the standing dry matter forage and identifying vegetation species. The "clip and weigh" method was used based on 3 measured and identified quadrates of 1m² each for positive indicator species. Consequently, a grazing management plan was developed. It contained a water management component where the rehabilitation of the water source of Ain el Loghlogh was done by cleaning its main source and instead of the barrels that used to be regularly maintained and replaced every two years, a concrete water tank was built and will be sustained by the municipality of Saghbine as well as the shepherds who use it.

On another hand, according to the project proposal, five enclosures of a total surface of 200 square meter for in-situ seeds replication were placed in the demo-plot; vetch seeds

will be harvested and saved for seeding in autumn. Furthermore, to ensure the participation of the shepherds in this management plan, incentives were distributed in the form of vaccines and anti-worm medication for 900 heads in Kherbet Qanafar and Saghbine villages. In addition, samples of cheese and milk were collected from the shepherds for microbiological analysis by ESDU experts for the promotion and conservation of traditional dairy products such as the distinctive "ambarees" cheese.

This case-study will help building a more efficient management plan for pastures by monitoring its pros and cons as it has been implemented in the same area of our project.

CHAPTER IV

RESULTS AND DISCUSSION

A. Collected data

1. Shepherds

The retrieved data covered 14 farms, owning all together a total number of 3643 heads, on average 260 animals per farm. Goats present 83% of this total number, and 17% are sheep, divided into 2138 milking goats and ewes, and 673 fattened kids and lambs per season, and each year, approximately 1246 heads are born. One important point to add is that 50% of the farms rely on their herds as the only source of income and rely on pasture grazing as a main source of feed for the flocks. The use of these rangelands and grazing routes are represented in table 3.

These results are in line with results found by other authors: Dick et al, (2008) recommended a diversification of income. Shepherds in Aarsal throughout the years have changed their production systems to cope with constraints: reduction of flock size thus reduction of feed supplements. And to be self-insured, they diversified their income, either from agricultural practices and off-farm activities.

As reported in this study, 56% of the rangelands are grasslands, 25% low density forests and 19% harvested lands of either wheat or legumes. In summer, grazing is conducted from March until August, 9 hours per day on average. In winter, shepherds remain on the same pastures, from September until February, 6 hours per day on average. Pastures of Bab Mareh mountains have the highest altitude 1500 meters and plain pastures of the same village have the lowest altitude of 800 meters.

Only 4 of these farms pay rent fees for grazing of these rangelands. Charges range between 1 000 000 LBP/dn and 25 000 LBP/dn.

Table 3 Pasture use and grazing routes of the chosen sample from database

Number of farms	Pasture	Region	Altitude (m)	Nature of pasture	Months spent on pasture	Number of hours	Rent fee (LBP/dn)
1	Summer	Saghbine	1000	grassland	March till November	6	1 000 000
	Winter	Saghbine	1000	grassland	December till March	6	1 000 000
2	Summer	Saghbine	900	Grassland	April till October	5	150 000
	Winter	Saghbine	900	Grassland	February till March	4	150 000
3	Summer	Ammiq	1000	Harvested land (wheat)	April till November	12	25 000
	Winter	Ammiq mountain	1200	Low density forest	September till July	12	0
4	Summer	Ammiq	1000	Harvested land (wheat)	March till November	10	30 000
	Winter	N/D					
5	Summer	Ammiq	850	Harvested land (legumes)	April till November	11	0
	Winter	Ammiq mountain	1500	Low density forest	January till March	6	0
6	Summer	N/D					
	Winter	Kherbet Qanafar		Grassland	December till March	2	0
7	Summer	Bab Mareh mountain	1600	Low density forest	April till November	10	0
	Winter	Bab Mareh mountain	1600	Low density forest	December till February	3	0
8	Summer	N/D					
	Winter	Kherbet Qanafar	1200	Low density forest	December till March	12	0
9	Summer	Bab Mareh	800	Grassland	April till November	12	0

	Winter	Bab Mareh	800	Grassland	December till March	6	0
10	Summer	Aitanit mountain	1100	Grassland	April till November	12	0
	Winter	Aitanit mountain	1100	Grassland	December till March	5	0
11	Summer	Ain Zebde	920	Grassland	March till November	6	0
	Winter	N/D					
12	Summer	Aitanit	1000	Grassland	January till November	6	0
	Winter	N/D					
13	Summer	Machghara	1050	Grassland	july till November	10	0
	Winter	N/D					
14	Summer	Saghbine	1050	Grassland	March till September	7	0
	Winter	Saghbine	1050	Grassland	December till March	5	0

As noted earlier, when pastures become depleted, especially in winter, on-farm feeding turns to be the main source of feed. The concentrate composition used is mainly wheat, barley, bran, corn, and some of the shepherds add soy, bean and lentil mash and legumes left overs, with an average of 2 kg/head/day (5 kg as maximum, 0.3kg as minimum). Shepherds tend to exaggerate their responses (3 to 5Kg/head/day) expecting to receive help or subsidies, knowing that concentrate cost are very high and none of them can afford the price of this quantity. As per Chedid (2018), shepherds in the West Bekaa supplement their flocks with an average of 1 kg/animal/day of concentrate. In addition to this concentrate, an average of 1.2 kg/head/day of hay is given. 10 farms outsource all of their feed from near suppliers, 2 produce 50 % of their feed, 1 produces 25% and 1 produces 75%.

The results show that on-farm feed supplementation is replacing rangeland grazing following the conflicts occurring among the shepherds and between shepherds

and local authorities, in addition to the depletion of natural pastures. These results are consistent with the literature showing that farmers in the Mediterranean and MENA regions are shifting to sedentary systems, as well as in Lebanon, to adapt the drought and scarcity of natural resources (Bistanji et al., 2000). Additional factors leading to this shift are inadequate policies regulating pasture management and land use and pasture management, limited governmental role in market regulations and border control and market regulations, and lack of financial and veterinary services (Chedid, 2019).

Before this shift, several factors have contributed to the decrease of the number of animals in the West Bekaa, as it has been reported by municipality representative in Ain Zebde, including the absence of support from local and public authorities (Chedid, 2019).

Based on the reported data, there was a big problem towards the presence of refugees. There is a high competition between local shepherds and Syrian shepherds over pasture grazing, racing to market product selling, infringement on villagers' lands and cultivations. This was also reported by the FAO (2014), rangelands were depleted generally by Syrian refugees' herds leading to competition over grazing between Syrian and Lebanese herds. It was suggested by another report by the FAO (2018) that more effort by the government should be placed to screen the Lebanese-Syrian borders and have a control over the increased prices of feed and the decreasing price and value of heads.

Results on the perceived changes in rangelands included the below observations:

- depletion of pastures following the increasing cultivated lands, grass quantities are decreasing over the years

- cultivation varieties and methods of cultivation have led to reduction in pasture productivity: beetroots and cabbage leftovers used to be grazed, now there is only harvested lands
- this depletion has affected farming activities and the herd's health: more time spent on pasture, increase of feed supplementation, quantity and quality of milk has declined
- decrease in forage quality and quantity is also caused by the increased drought seen by the herders and the decreasing in precipitation over the years
- reaching pastures is challenging for some herders due to agricultural encroachment
- water availability is also diminishing, making shepherds buy cisterns of water, hence adding cost to their activity.

2. People who forage

The results on foraging activities are listed in table 4, covering the benefits from the pastures. The results show that the reported foraging activities is all delivered from people who live permanently in the sampled villages, men and women. The approximate time needed for these people to reach the pastures is one hour walking as maximum and 5 minutes as minimum, 28 minutes on overall average. Rangelands used are plains, mainly private and public and none are rented. The reported benefits from the rangelands are: collection and sale of wood to nearby clients, collection of wild edible plants and selling them either fresh or cooked as well as for household consumption which is the predominant benefit. The main edible plants that are collected are: Eryngos, Elm, Dock,

Common Purslane, Fennel, Borage, Cheesweed, Cichorium intybus, Ramsons, Scorzonera, Silybum Marianum in Machghara and Diplotaxis in Aitanit, in addition to apple trees, peach, olive, grape, pear, almond, walnut, apricot and quince trees. The beneficiaries who sell wood, also hunt birds and wild pigs. Bees, bats, birds, butterflies, wild pigs, snakes and foxes are seen when on pastures.

Grasslands provide gene pools for a diversity of economically important fauna and flora species which conserve the value for humankind. A great number of domesticated animals and plants such as onions, herbs, wheat, sheep, cattle and goats were originated in the pastures of the Mediterranean region and several medicinal plants (Sala and Paruelo, 1997).

In every village rangelands, water sources are available except in Aitanit:

- 4 rivers in Saghbine and one spring
- 1 spring in Khorbet Qanafar and 30 wells
- 4 springs in Ain Zebde
- 1 river and 2 springs in Machghara

Rangeland ecosystems are often decorated with seasonal and permanent wetlands such as springs, lakes and rivers which supply freshwater resources to people. These are the key source of irrigation and drinking water, and represent the nomadic pastoral culture of living with water and grass (Zhao et al., 2020). Pastures are vital for regulating regional and local water quality and redistribution. Water is a crucial limiting factor for ecosystem and biodiversity progressions in rangelands (MEA 2005). Grassland flora affects the special and temporal outlines of aquifer water renew, floods and surface runoff, (Egoh et al., 2008).

Rangelands control the water quality by reducing the toxicity and quantity of pollutants as well as regulating the generation of pollutants, and changing their migration course (Macleod and Ferrier, 2011).

Moreover, a commonly reported benefit refers to a change of climate when moving to the rangelands: cleaner air, better smell, quieter. Although, in Saghbine polluted air and bad smell are sometimes reported because the pasture was near the Qaraoun lake.

Cultivation and desertification of pastures, as well as overgrazing and urbanization are a major source of carbon emissions. Rangelands can act as carbon basins, and might act as carbon sources during heat waves and drought (Freibauer et al., 2004). Most of the soil organic content are found in the soil and not in the biomass, as grasslands reduce soil losses as it is an everlasting soil cover (Huyghe et al., 2014). In a study conducted by Cao et al. (2015), showed that following grassland degradation in Inner Mongolia, China has led to a weighty increase in near-surface temperature, whereas restoring the vegetation has led to an important cooling effect. Sun and Chen (2017) found in their study that rangelands can reduce land surface temperature, ease heat island and intensify summer comfort in urban environments.

Following the economic crisis, ecosystem services did not change, except for a noted increase in consumption and product selling in hosting facilities because people tend to visit quieter places, far from big cities for vacancies and recreation as it is cleaner, cheaper and safer. Furthermore, the sale of forages to nearby villagers for additional income was observed.

During the last 10 years, the observed changes in rangeland include the disappearance of the Borage because of the excessive use of pesticides, and the quantity of *Scorzonera* has decreased following the uncontrolled grazing of flocks. It is important

to note that these changes are as perceived by few foragers, while others may not notice any changes regarding the species present and their quantities. No projects or rangeland management plans were declared to be implemented in the villages, except in Aitanit, newly built paths on pastures, allowing flocks to move easily between the cultivated fields, but have been destroyed by the small ruminants.

As noted by Brown and MacLeod (2017), rangelands support several domestic animals that are sources of milk, meat, wool, like sheep, cattle and buffalos. And Honigova et al. (2012) stated that the existence of semi natural legumes and grasses have a direct effect on the expansion of animal husbandry and livestock performance.

The impact of the supporting services on humans often occurs over a long period of time, whereas the other services have short-term or direct impacts on humankind. Empowering the ecosystem processes and functions essential for the delivery of the provisioning, regulating and cultural services, biodiversity is classed within the supporting services. Once a specie is introduced to or lost from a specific location, the numerous ecosystem services related with that specie are altered, often with immediate and influences on humans. Ecosystem services can be indirectly affected over longer eras by changes in biodiversity, such as manipulating ecosystems' ability to adjust to these changes, causing irreversible variations in ecosystem processes. (Millennium Ecosystem Assessment, 2005)

The cycles of many key nutrients have been significantly altered by human activities, with vital consequences for people's well-being and for a number of other ecosystem services. Nutrients are mineral elements like potassium, phosphorus and nitrogen, essential as raw materials for organism development. Concentrations and flows of these

nutrients are regulated by the through complex processes allowing them to be recycled from dead organisms or mined from their mineral sources.

The cycling of biomass through the use of livestock's urine and manure as soil fertilizer, has been a key linkage between soil productivity and livestock in semi-arid regions (Powell et al., 1996).

Table 4 Pasture benefits for the chosen sample

	Percent of foragers
Selling products	54%
Household consumption	100%
Foraging	100%
Hunting	36%
Woodcutting	36%

The presence of refugees has caused many obstacles for the villagers, shepherds and rangeland users of the West Bekaa, leading to a negative impact on the local community's livelihoods, as retrieved in the results:

- Picking fruit trees of land owners and sell it to the market, as well as in the vine yards, and selling the harvest in lower prices.
- Cutting innated plants in the wrong way not letting it regrow, causing disappearance of some species and decrease their quantities.
- Cutting oak trees in harmful ways and sell it as wood.
- Concerning the shepherds, several refugees own flocks and race the villagers for grazing, as well as entering cultivated lands with their herds causing damages and overgrazing
- Racing to the market, selling their dairy products in lower prices

3. *Local authorities*

In all towns, either grazing is prohibited or practiced illegally following several conflicts.

- In Machghara, grazing is forbidden because flocks damage cultivated private lands, but some shepherds graze illegally. When damage is caused, the municipality tries to sanction the herders but political interventions protect them from these sanctions. In addition, the municipality tried to hire forest wardens, but the shepherds kept getting in conflict with them. Grazing management plan concerning tree protection and afforestation was implemented in Machghara: division of pastures into plots that each shepherd will rent, take care of it and graze in it at the same time, but following the lack of knowledge and awareness of herders, they did not cooperate thinking the local authorities has bad intentions toward them. Therefore, the plan was canceled.
- In Aitanit, grazing is also forbidden by a republican decree from the 60' because the whole village is considered as reserve. Throughout time, some exceptions were made concerning grazing, especially during the pandemic of Covid-19. The municipality tried to implement a rangeland management plan, but the problem was that most of the land are private and public ownerships and the local community doesn't like the presence of herders following their overgrazing and damages to the lands. In addition, when the flocks graze new trees, soil erosion is caused as the mountains of Aitanit are rocky.
- In Ain Zebde, there is no local shepherds. Herders from neighboring villages like Saghbine and Kherbet Qanafar come to Ain Zebde to graze while damaging cultivated lands, therefore the local community is not welcoming the flocks.

Case studies on pastoralism in Lebanon show that rangeland use is seriously affected by several factors mainly the lack of suitable national policies on land use and tenure relevant to pastures preservation and management. As seen in the literature, policies and laws concerning rangeland managements are either outdated or not available (Chedid, 2019, Hamadeh et al., 2005).

In the visited municipalities, all the regulations are not official causing the forbiddance of grazing, and despite the restrictions, grazing is occurring with damages. In Aitanit grazing is forbidden by a republican decree from the 60'. Therefore, policies should be recommended and sanctions should be taken into consideration with formal decrees to prevent overgrazing and damages towards pastures and cultivated lands. The forbiddance of grazing is not a healthy solution as grazing favors certain fauna communities and leads to larger species diversity through formation of gaps, as well, grasslands can be preserved only by the influence of grazing (Grime, 1979). In addition, small ruminants' dung is a significant source of nourishment for many insects and birds (McCracken et al., 1992).

To improve the grazing sector, a national strategy for the conservation and management of pastures should be conducted with the help of policy makers, rural land organizations and representatives of pastoral societies, preceded by an assessment of rangelands starting on the national level (Hamadeh et al., 2005).

The services of the MoA should be reinforced and follow ups and training must be provided afterwards to improve the capacity of shepherds. Policies and legislations concerning pasture management should be updated and revised in a system that clarifies the responsibilities of protection, programming and grazing capacities (Chedid, 2019).

B. Case study

The data retrieved for this case-study revealed many challenges faced by the farmers and mainly related to:

- rangeland quality and access,
- water accessibility and availability,
- diseases withing the herds,
- lack of governmental support,
- financial problems as high-cost production including labor and feed prices,
- low access to market also affected by the Syrian crises affecting market pricing.

Personnel involved in the SPNL project identified an additional challenge concerning the case study: part of the local community dislikes the presence of flocks in the village, is bothered by the smell and the herd's entrance to private lands. In addition, several shepherds of the West Bekaa entering the Shouf reserve damage new seedlings leading to a slow regeneration of the green cover.

The village of Ain Zebde was selected by SPNL as a case study as it was part of a bigger project also led by SPNL aiming to introduce the mountains of Ain Zebde into the Hima rangelands. Although there are no herders in Ain Zebde, and the shepherds who used to graze on the rangelands in Ain Zebde are one shepherd from Saghbine and two others from Khorbet Qanafar.

Due to internal problems within the municipality of Ain Zebde, its mayor withdrew from the project. Negotiations were made with the municipality of Kherbet Qanafar, where the number of herders is higher than the other villages and the project would have been the best to be implemented in this village. But following the rejection of the

municipality, it was afterwards decided by SPNL after discussions with the municipality of Saghbine, to allocate the case study to the mountains of Saghbine, sharing common characteristics with Ain Zebde in relation to vegetation, climate and nature of rangelands.

Unfortunately, due to the lack of time and funding, the rangeland management in Saghbine was developed without a new assessment for the new location. Very commonly, NGOs face the possibility of not being able to offer high quality and quantity in their involvement, due to lack of funds to cover the expenses (Harir, 2015).

Concerning the implemented plan in Saghbine, the rehabilitation of the water point of Ain Loghlogh was successful and beneficial for the herders in the village and in the region, especially in the Summer when water sources are scarce. The half-barrels that needed regular maintenance and replacement every couple of years were transformed into durable concrete water tanks.



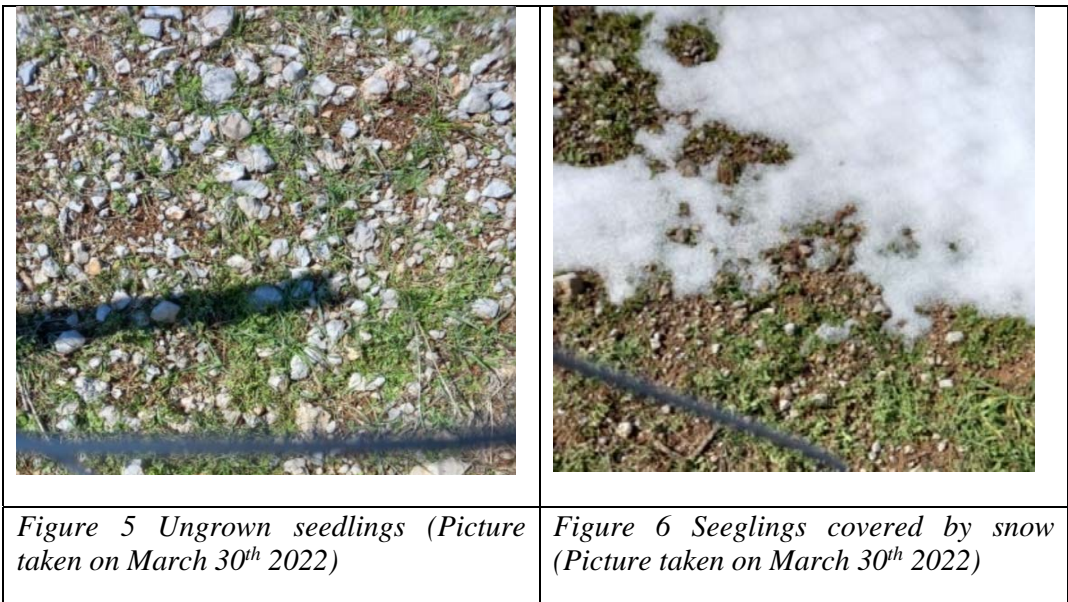
Figure 3 Old barrels at Ain Leghlogh water source in Saghbine (Source: ESDU)



Figure 4 Old cement water reservoir that was renewed (Source:ESDU)

The tasks of this project were divided between the parties: SPNL was leading the project, responsible for the sustainability of the plot and follow ups on the project. ESDU

were the consultants for the project, responsible for the implementation of the plan and the technical part (assessment, report, activities and steps to be done...). Although in ESDU's final report included the formation of a steering committee post project to ensure its sustainability, the committee was not formed. Regarding the reseeding the enclosures established in the rangelands, the procedure proved a little success due to harsh weather conditions that prevailed during the germination season.



A key point for a project to be successful is the strong network and communication between the NGO concerned and the local authority, mainly the municipality, and to present recommendations taken from other projects.

A bottom-up approach should have been conducted to determine the most proper villages for this case study, and the development of the project follows depending on the need of its community. The bottom-up method includes respecting the culture and ideas of the rural communities, involving their visualizations and needs during project execution and respecting their economic life style and then based on all the above, the goals of the

project are improved and its sustainability. This approach helps the donors, government experts, and foreign organizations to fully integrate with the rural community and gain their acceptance in return. It gives the locals confidence and high motivation to be working with them and accept their involvement (Isidiho, and Sabran, 2016).

In order to implement a project in a demo-plot, its development should be based on the needs of the community targeted in order to reach their demands and the goals of the plan. According to Rached (2002), the fluctuations occurring in the dairy sector throughout the years show, that there is missing points in the pre-plan assessment and policies and development programs or policies have been implemented without taking into consideration the several existing farming systems. These unsustainable and inefficient policies and programs attest that top-down approaches block the participation of important stakeholders, processors and farmers, in the development and decision - making.

CHAPTER V

CONCLUSION AND RECOMMANDATIONS

This study was conducted with an assumption that a sustainable rangeland management can improve the ecosystem services for small ruminant herders and rural people, especially in the West Bekaa. Pasture may act as efficient conservation of social security and a key for regular income and work against economic stresses. Livestock production in Lebanon, especially in the chosen area, is suffering from poor access and ability to buy feed, and pasture availability, following the years of uncontrolled and non-sustainable rangeland use, degrading them and reducing their values for herd grazing and pasture beneficiaries.

Results identify that following overgrazing and expansion of agricultural lands, leading to the depletion of pastures, shepherds are shifting to sedentary farming systems causing increase of farming cost for feed supplementation making it hard to continue with their activities. Therefore, sustainably managed pastures are assumed to be the solution for preserving long-term livestock productivity. With unavailable governmental support and absence of laws and policies, management of pastures is not available and as seen in the results, 50 % of the shepherds only rely on herding only for their livelihood, therefore, to sustain their living, diversification of income should be thought of.

Based on this study, ecosystem services of rangelands to rural people in the West Bekaa are found to be several. The beneficiaries sell wood to nearby clients, vend homemade pantry to tourists and visitors, and sell edible plants to villagers. All foragers use edible wild plants for household consumption in addition to many varieties of fruit trees. The beneficiaries also hunt birds and wild pigs. Bees, bats, birds, butterflies, wild pigs, snakes and foxes are seen when on pastures. In every village, permanent water

sources used for irrigation, livestock hydration and direct consumption, are available except for Aitanit. This water's quality is controlled by rangelands by reducing the toxicity and quantity of pollutants as well as regulating the generation of pollutants, and changing their migration course. All users of rangelands notice a change of climate when moving to the rangelands: cleaner air, better smell, quieter, as rangelands act as carbon basins, except in Saghbine where it was mentioned that polluted air and bad smell are sometimes present because the pasture was near the Qaraoun lake.

In the chosen villages, grazing is forbidden because of the immense conflicts that occurred during the years between shepherds and local community and between the shepherds themselves. This forbiddance is not a healthy solution for pastures as small ruminants benefit the generation of rangelands. Therefore, to improve the grazing sector, a national strategy for the conservation and management of pastures should be conducted with the help of policy makers, rural land organizations and representatives of pastoral societies, preceded by an assessment of rangelands starting on the national level.

The case study of SPNL chosen to be interpreted aimed to demonstrate best practices on high mountain pastures restoration implemented in partnership with local municipalities and shepherds. The plot chosen was located in Ain Zebde where the assessment was conducted. Due to several conflicts occurring within the municipality, the plan was allocated to Saghbine without a new assessment. Although a lot of effort was put in the delivery of the project goals, it has failed to be reached due to different factors, either lack of time or funding, lack of communication between the parties involved.

A key point for a project to be successful is the strong network and communication between the NGO concerned and the local authority, mainly the municipality, and to present recommendations taken from other projects.

In order to implement a project in a demo-plot, its development should be based on the needs of the community targeted in order to reach their demands and the goals of the plan. A bottom-up approach should have been conducted to determine the most proper villages for this case study, and the development of the project follows depending on the need of its community.

In addition, a national institutional framework should be formed so the local community and the local authorities can work in collaboration, and a proper management plan be formed based on previous project sited in the literature.

APPENDIX I

ON-FARM FEEDING PRACTICES OF THE CHOSEN SAMPLE

Table 5 On-farm feeding practices of the chosen sample

Village	Concentrate composition	Average quantity (Kg/head/day)	Hay average quantity (Kg/head/day)	Feed production (%)	Feed outsources (%)
Ain Zebde	Barly, corn, wheat	3	1	0	100
Saghbine	Barley, corn, wheat, bran, salt, vitamins, calcareous materials	1	1	0	100
Saghbine	Barley, vegetable leftovers	5	2	50	50
Saghbine	Wheat, barley, legumes leftovers	4	2	0	100
Ammiq	Wheat, barley, bran	1	1	0	100
Ammiq	Wheat, barley, bran	1	1	0	100
Ammiq	Bran, barley, alfalfa	0.3	0.2	50	50
Khorbet Qanafar	Wheat, barley, bran, soja	1	0.5	0	100
Khorbet Qanafar	Barley, wheat	1	1	0	100
Bab Mareh	Corn, wheat, soja	0.5	1	0	100
Bab Mareh	Bran, wheat, legumes leftovers	0.5	1	0	100
Aitanit	Legumes leftovers	N/D	0.75	0	100
Aitanit	Corn, barley, wheat, bean mash, lentil mash	3	2	25	75
Machghara	Barley, wheat, bran	3	3	75	25

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